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**Malmassari et al.**

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(54) **BOOM HOSE APPARATUS**

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(2013.01); *E02F 3/8816* (2013.01); *E02F 3/90*  
(2013.01); *E02F 7/02* (2013.01); *F16L 3/01*  
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9/244; A47L 9/248; E01C 19/475; E01H  
1/0827; E01H 2001/0881; E03F 7/106;  
E02F 3/8816; E02F 3/90; E02F 7/02;  
F16L 3/01

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See application file for complete search history.

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(56) **References Cited**

U.S. PATENT DOCUMENTS

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6,792,646 B1 9/2004 Greene et al.  
7,712,481 B1 5/2010 Mayer et al.  
2002/0020760 A1 2/2002 Beggs  
(Continued)

(22) Filed: **Aug. 31, 2020**

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FOREIGN PATENT DOCUMENTS

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OTHER PUBLICATIONS

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**F16L 3/01** (2006.01)  
**B60P 1/60** (2006.01)  
**A47L 9/00** (2006.01)  
**E01H 1/08** (2006.01)  
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Invitation to Pay Additional Fees for PCT Application No. PCT/  
US2019/016060, dated May 22, 2019, 14 pages.

(Continued)

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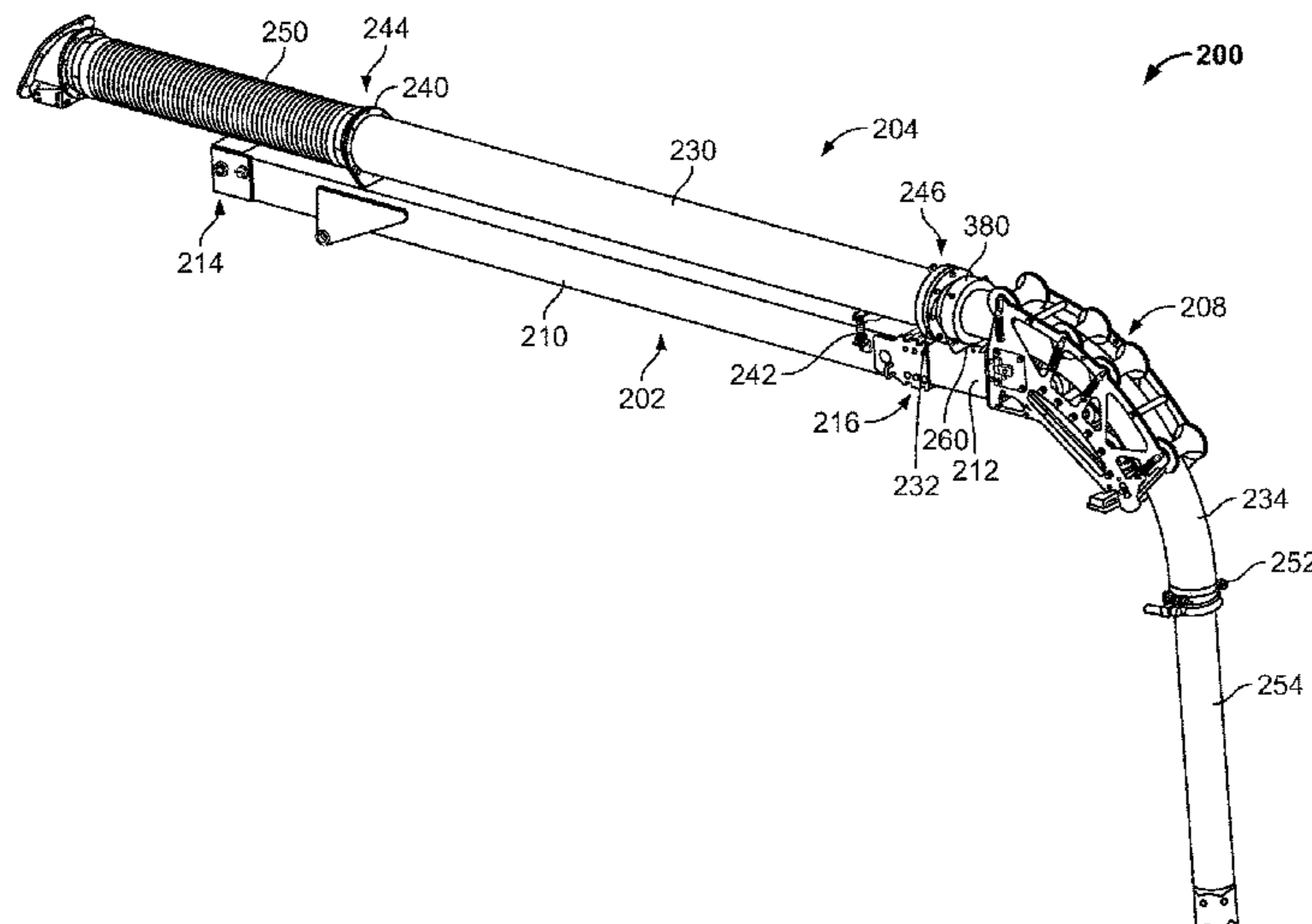
(57) **ABSTRACT**

A boom hose apparatus for a material collection vehicle  
includes a telescoping boom assembly and a hose assembly  
supported by the boom assembly. The boom assembly  
includes a plurality of telescoping conduits. A flexible hose  
is received through the telescoping conduits and can slidably  
extend from, or retract into, the conduits independently from  
the telescoping of the conduits.

**3 Claims, 14 Drawing Sheets**

(52) **U.S. Cl.**

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**19/475** (2013.01); **E01H 1/0827** (2013.01);



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*E02F 7/02* (2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2010/0018590 A1 1/2010 Damaske et al.  
2015/0075624 A1 3/2015 Mahaffa et al.

OTHER PUBLICATIONS

International Search Report and Written Opinion for Application  
No. PCT/US2019/016060 dated Sep. 4, 2019, 22 pages.

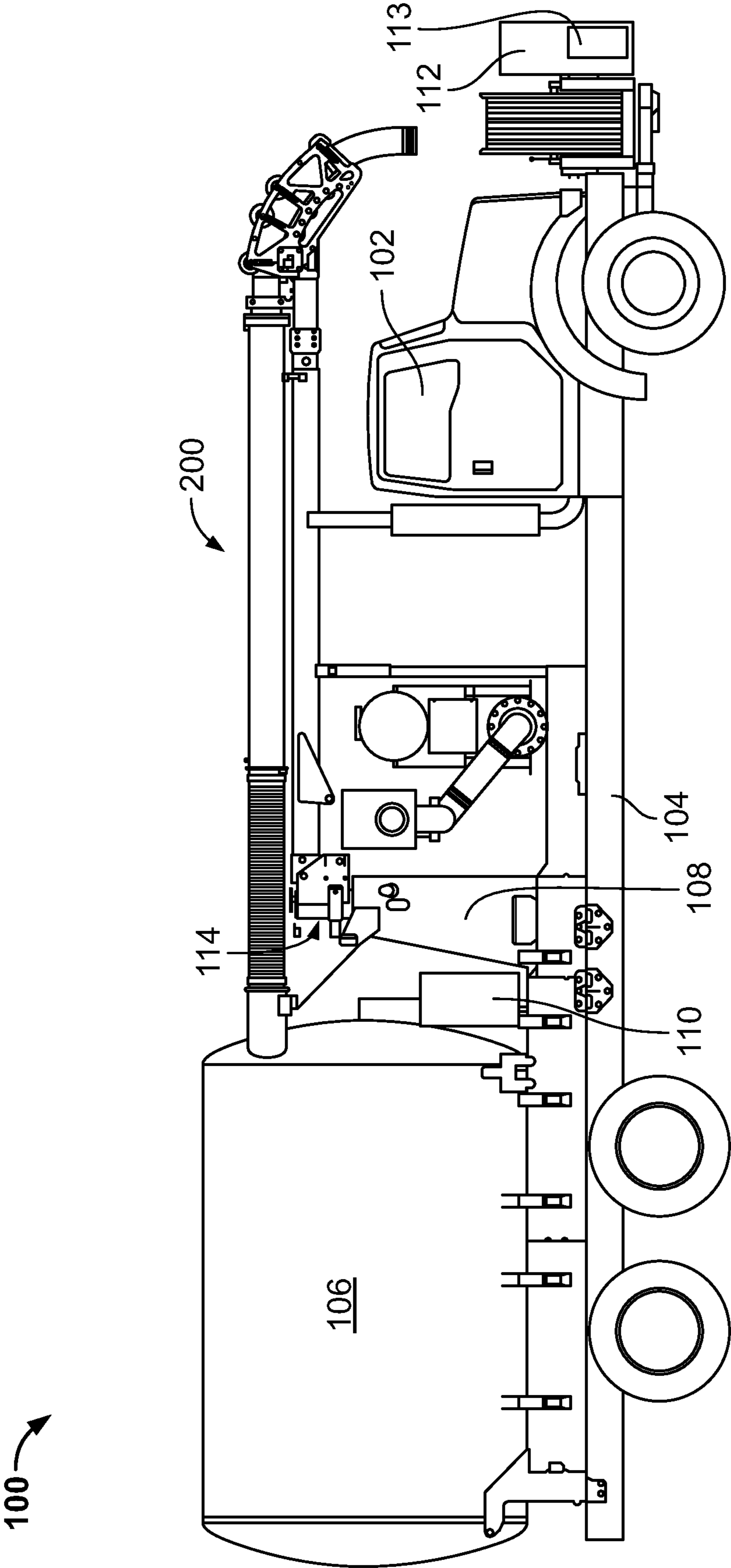


FIG. 1

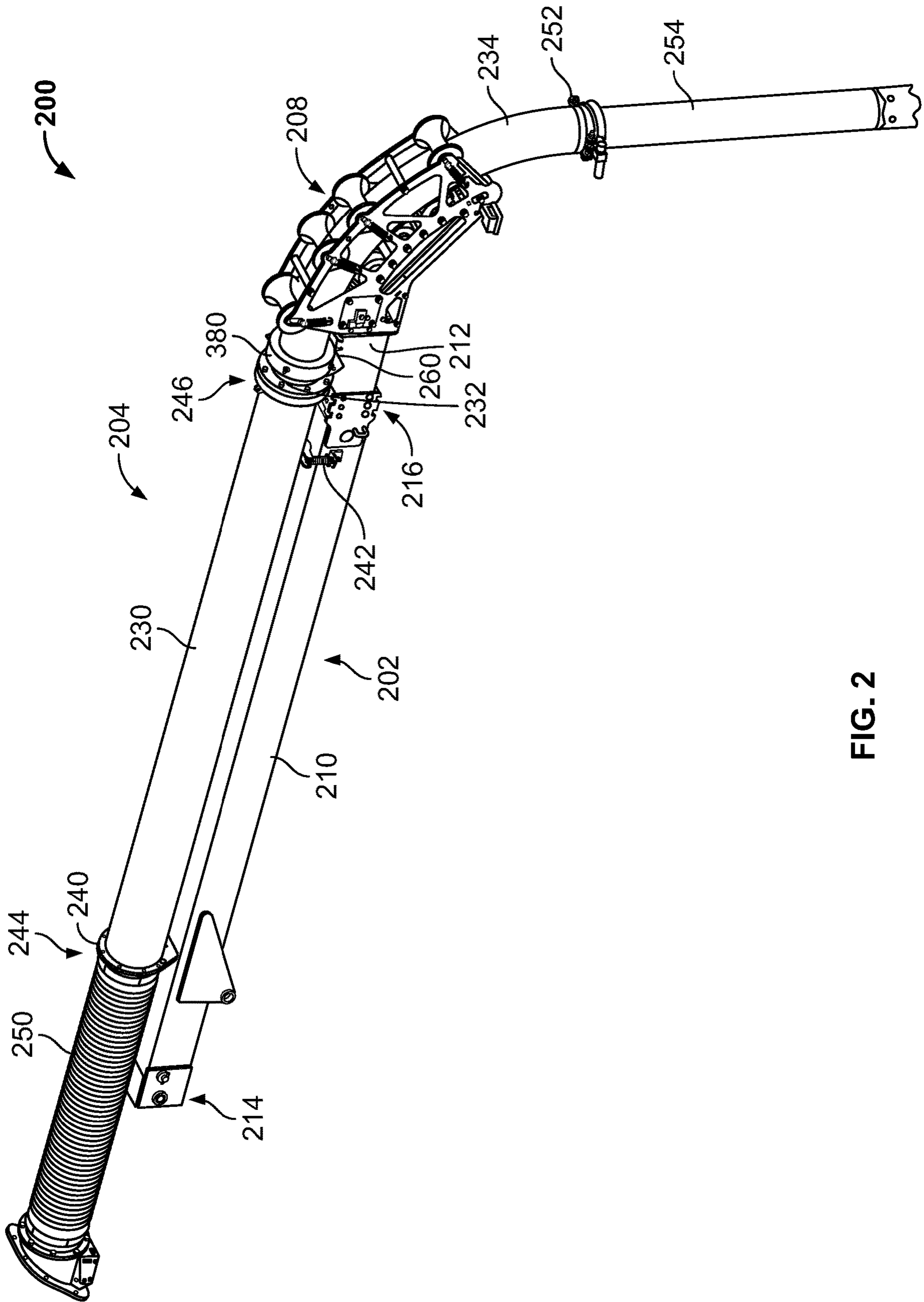


FIG. 2

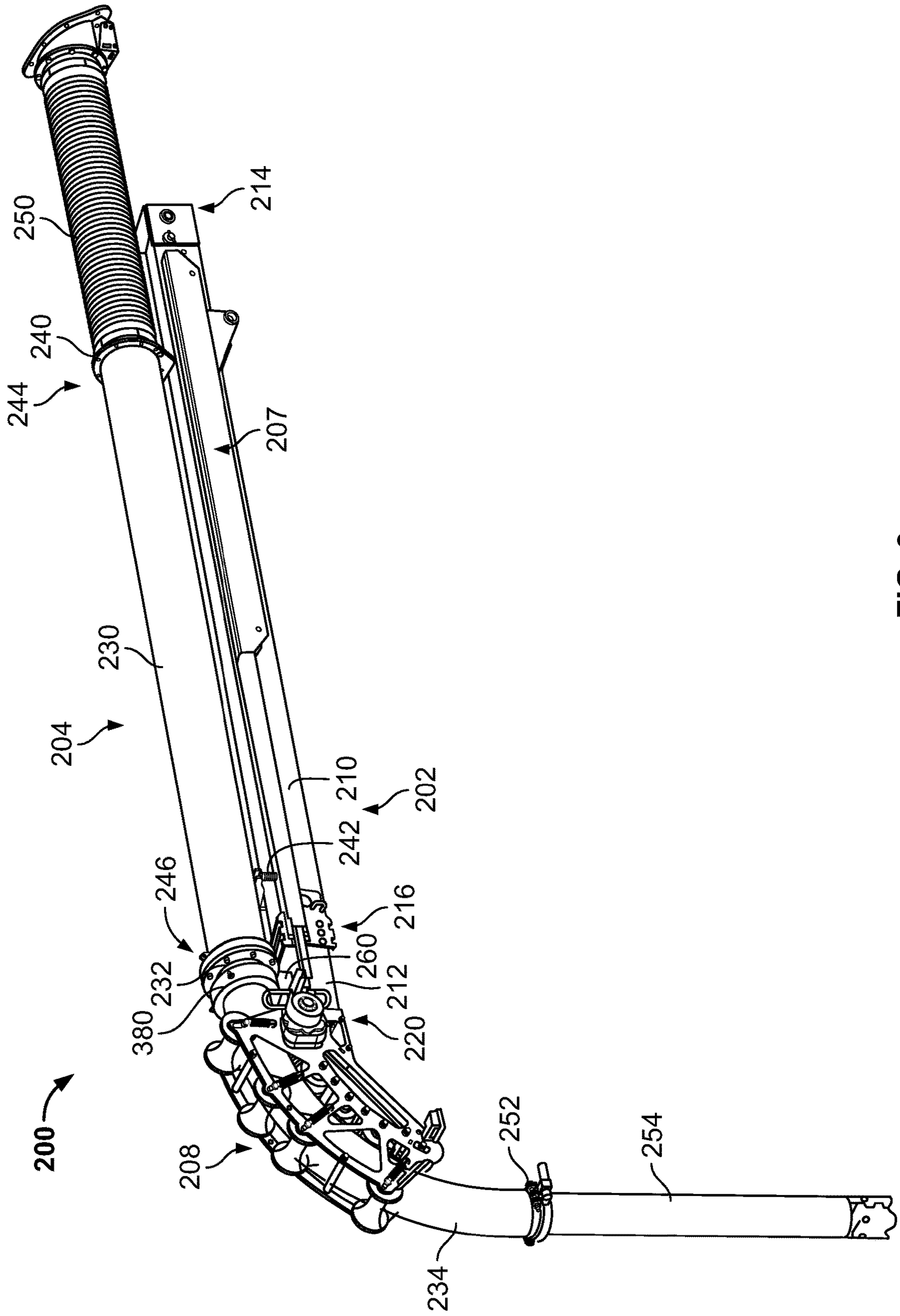


FIG. 3

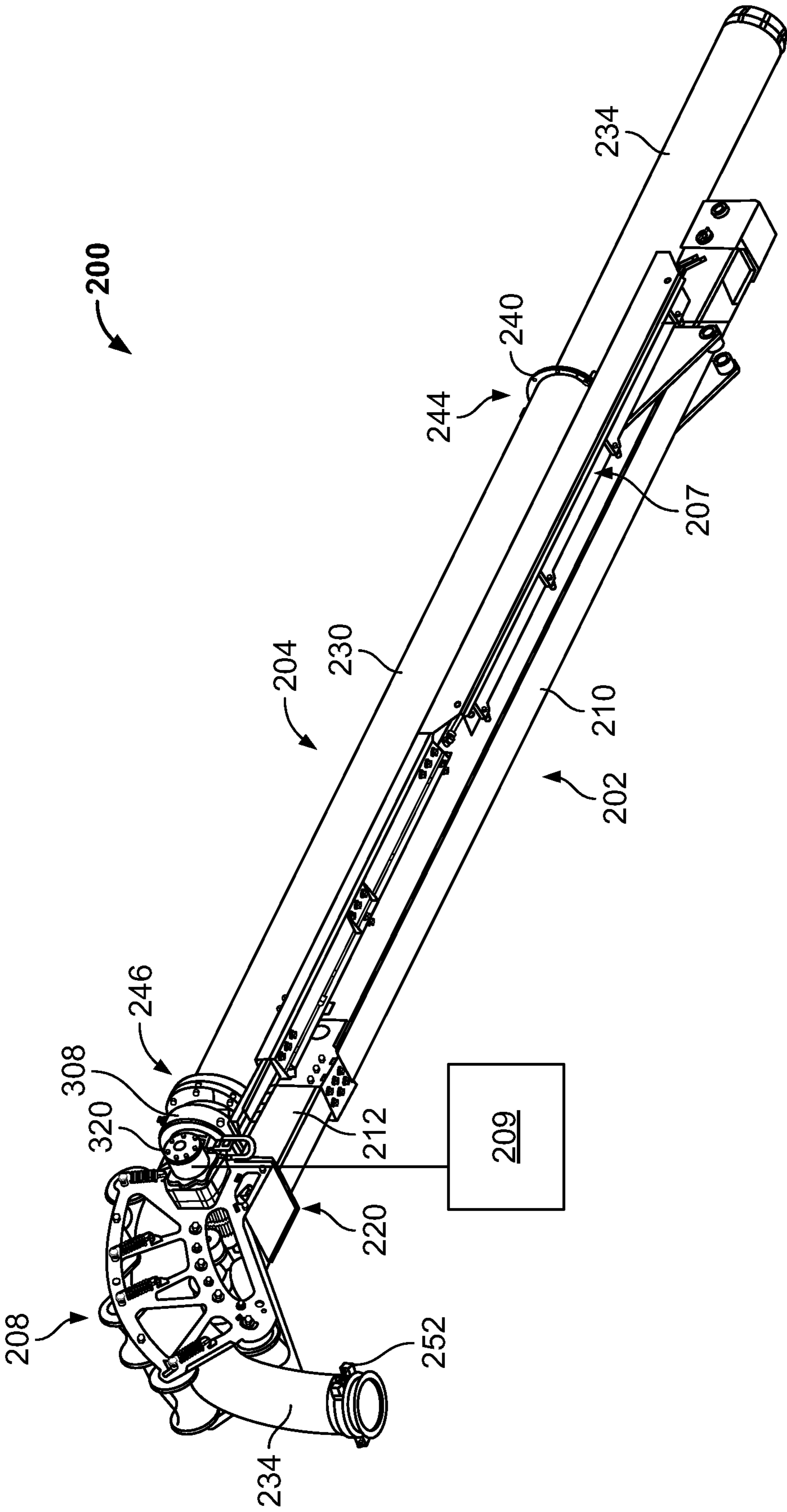


FIG. 4

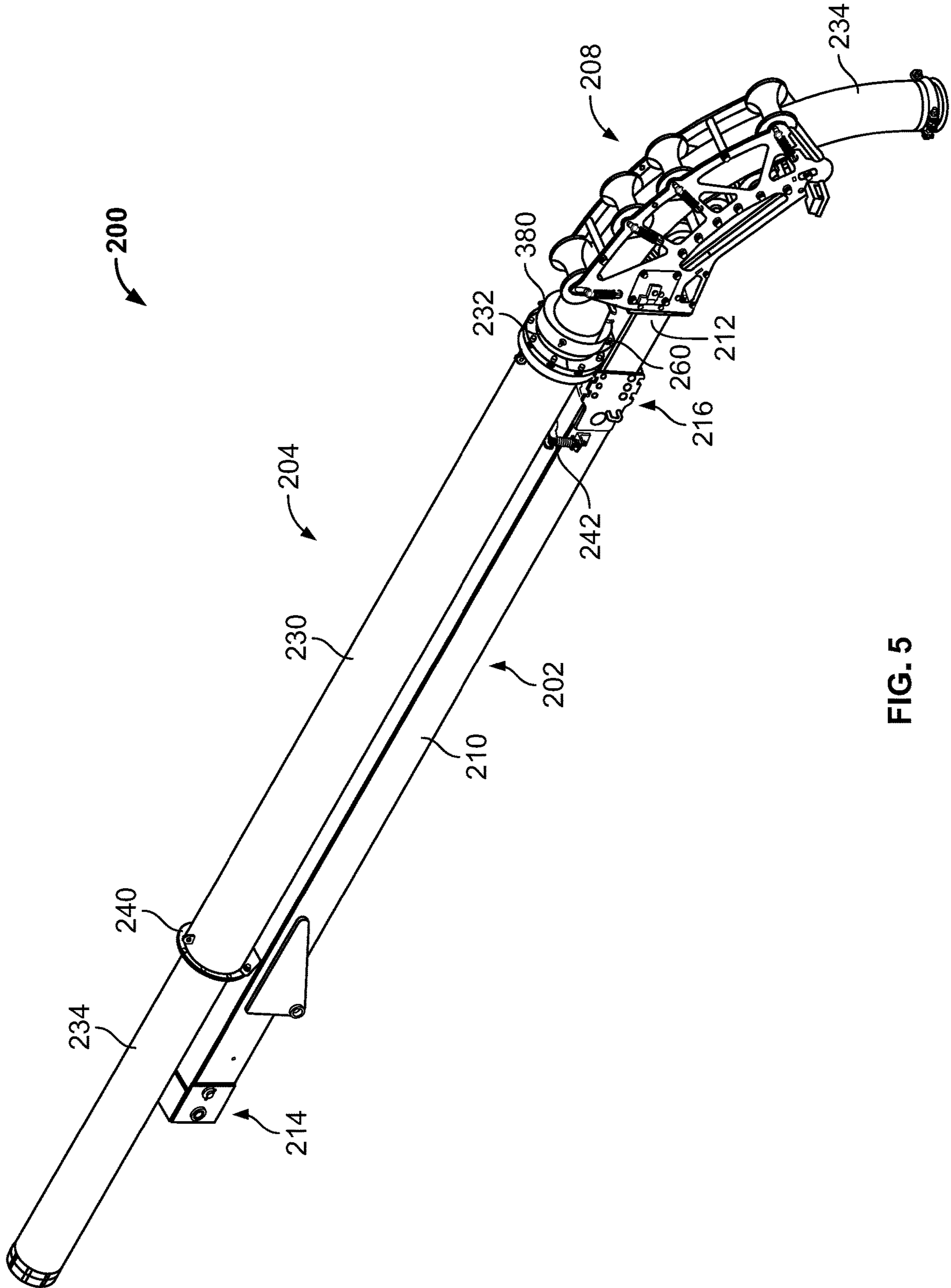


FIG. 5

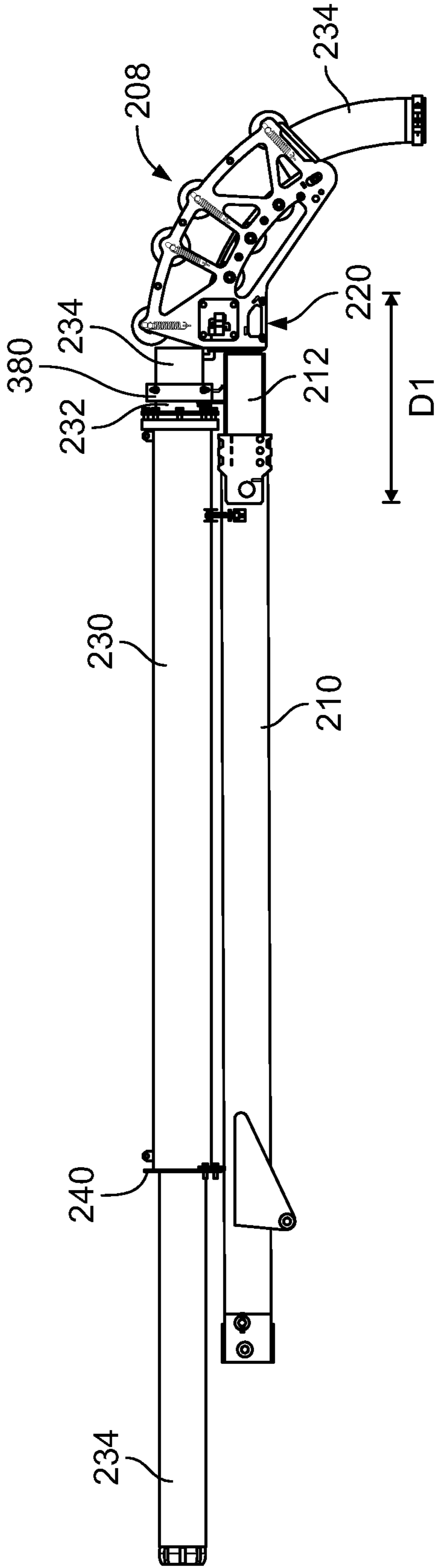


FIG. 6

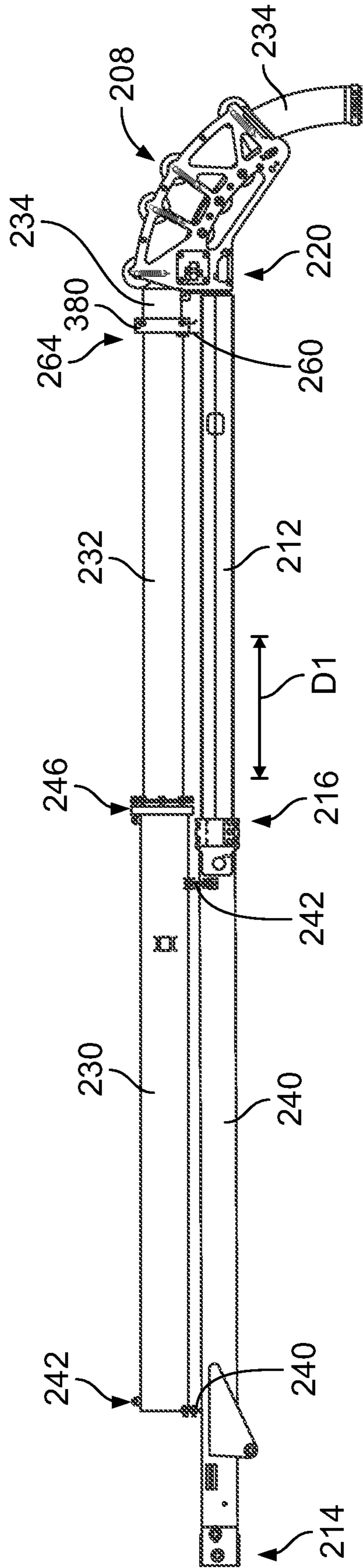


FIG. 7



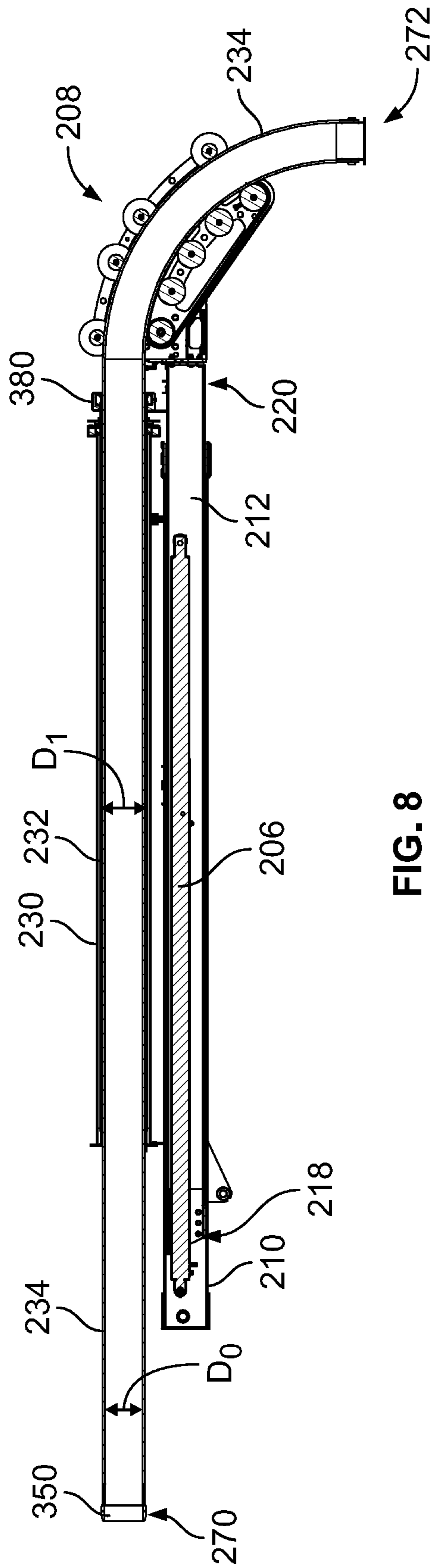


FIG. 8

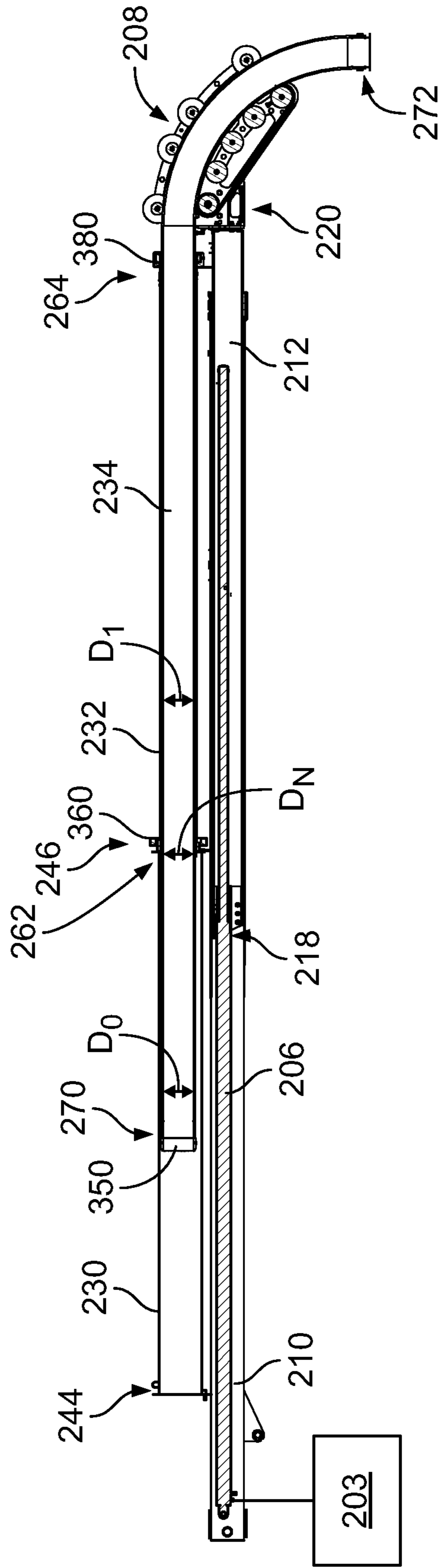


FIG. 9



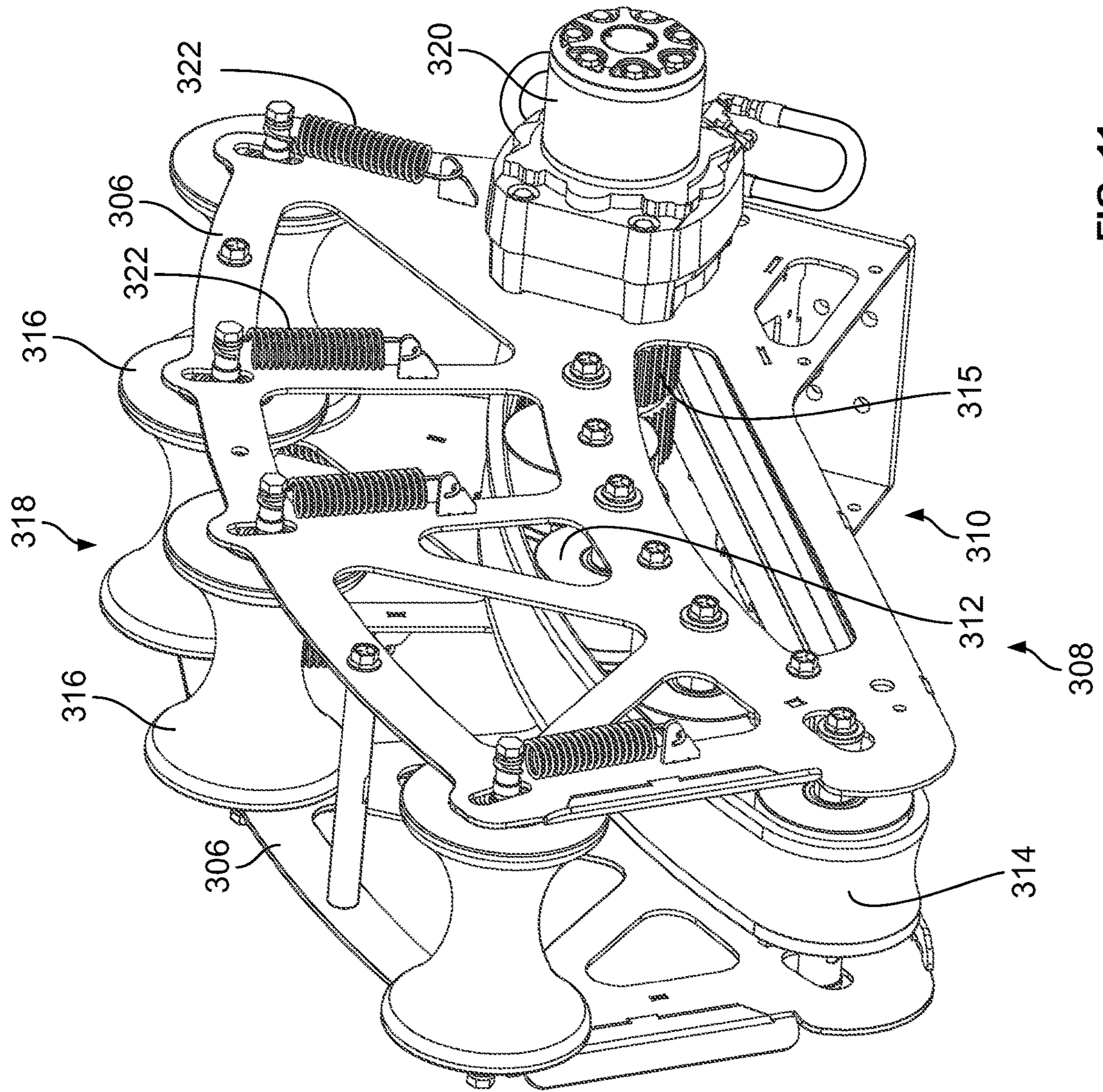


FIG. 11

350

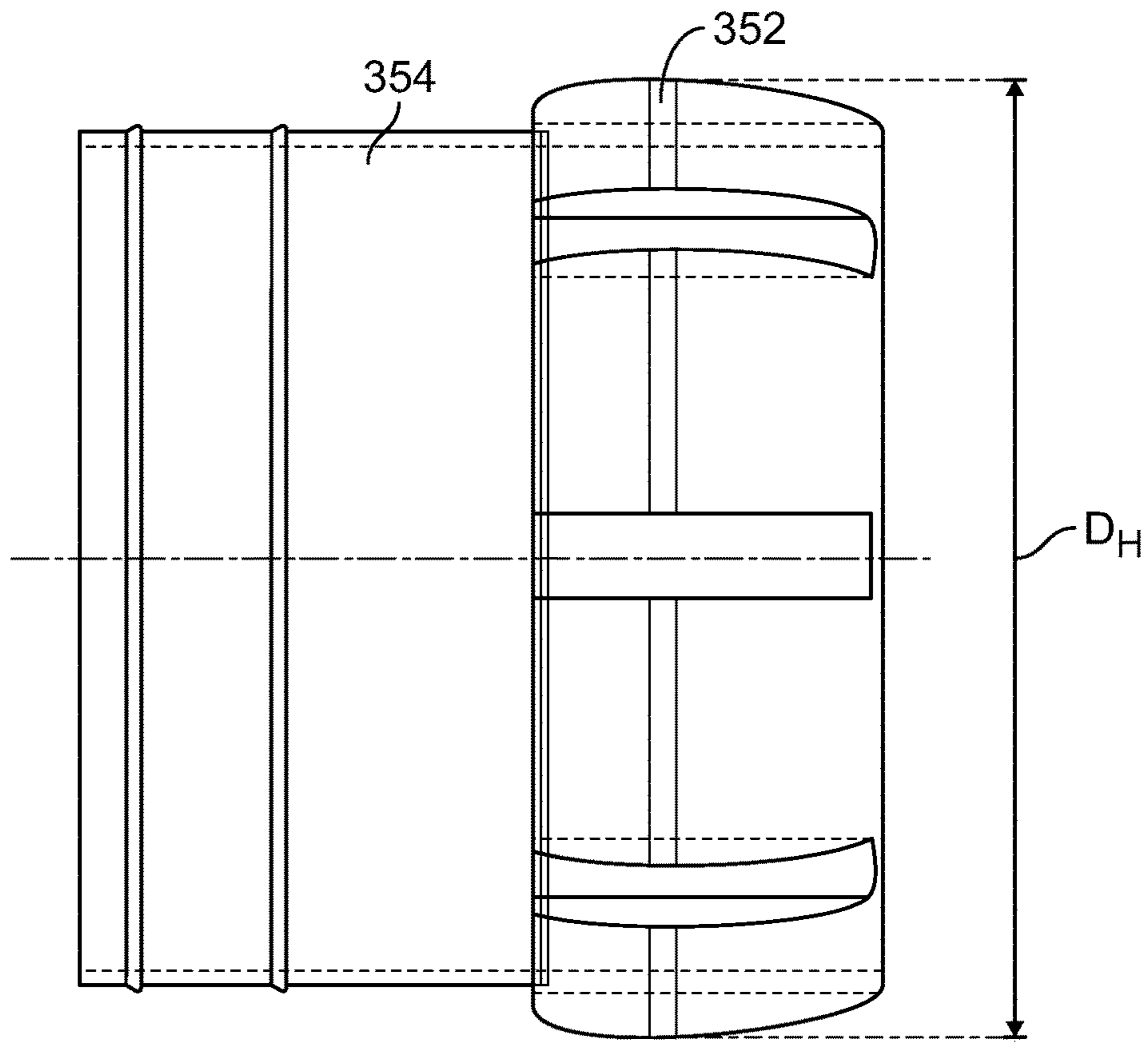


FIG. 12

350

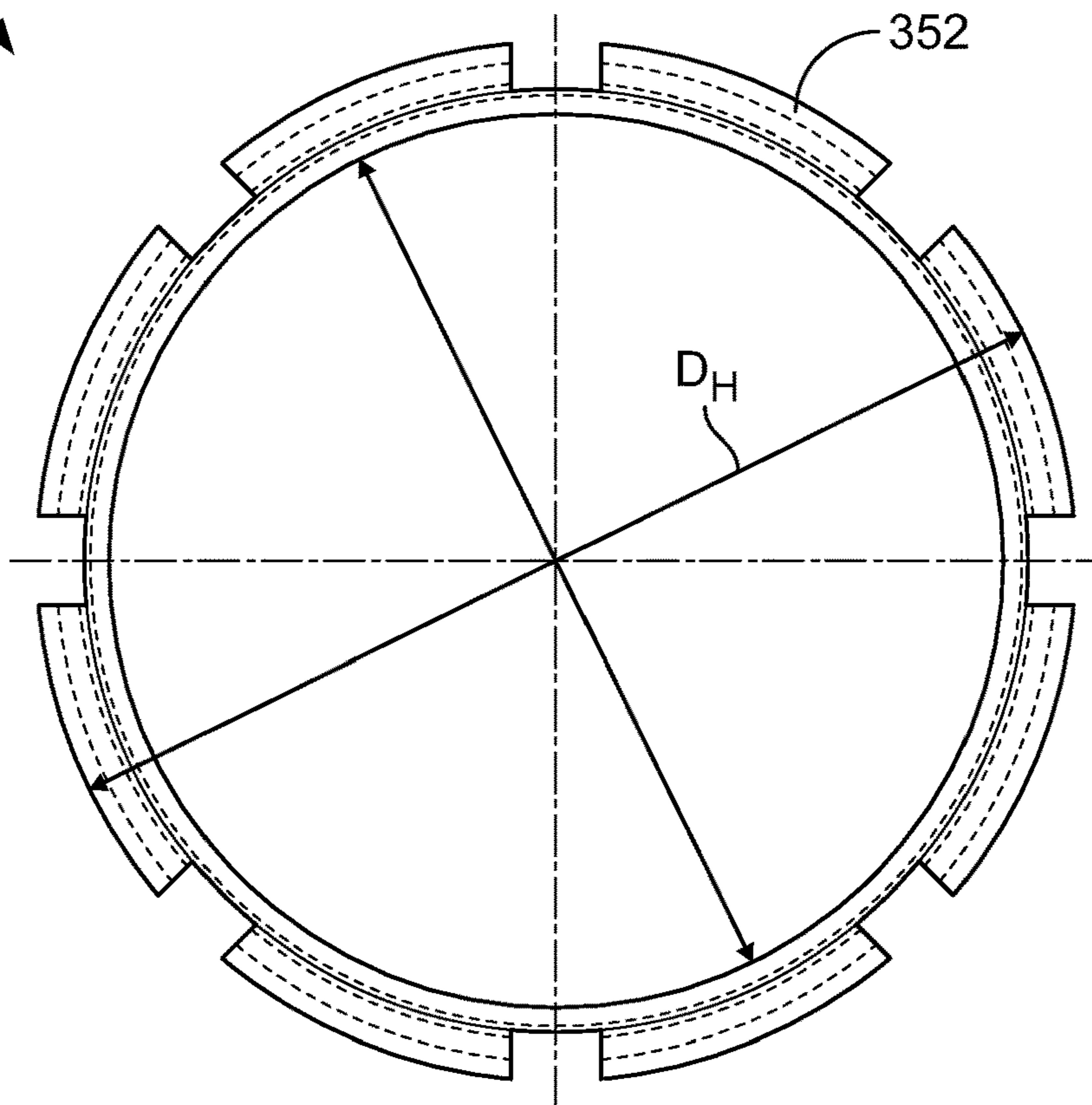


FIG. 13

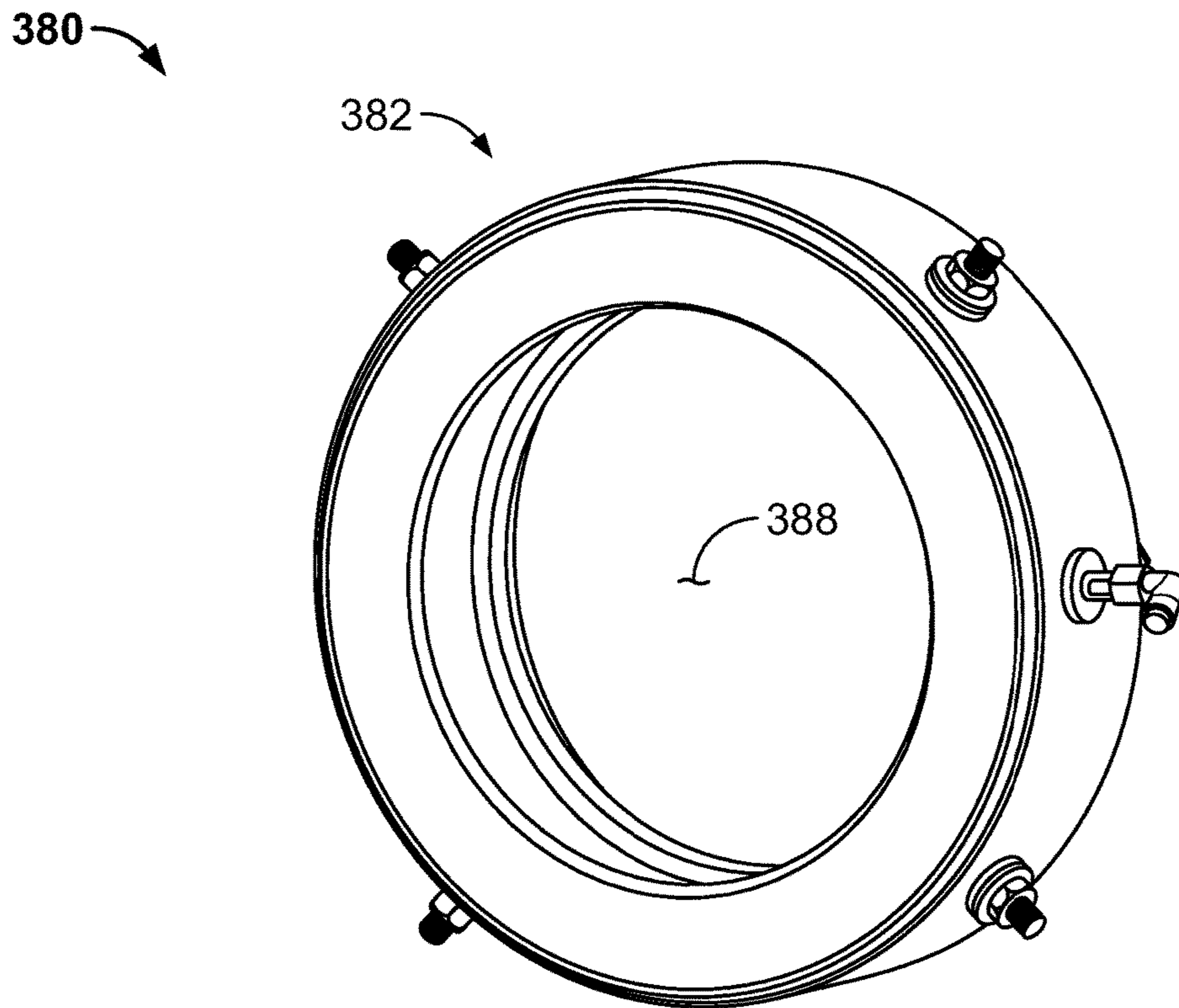


FIG. 14

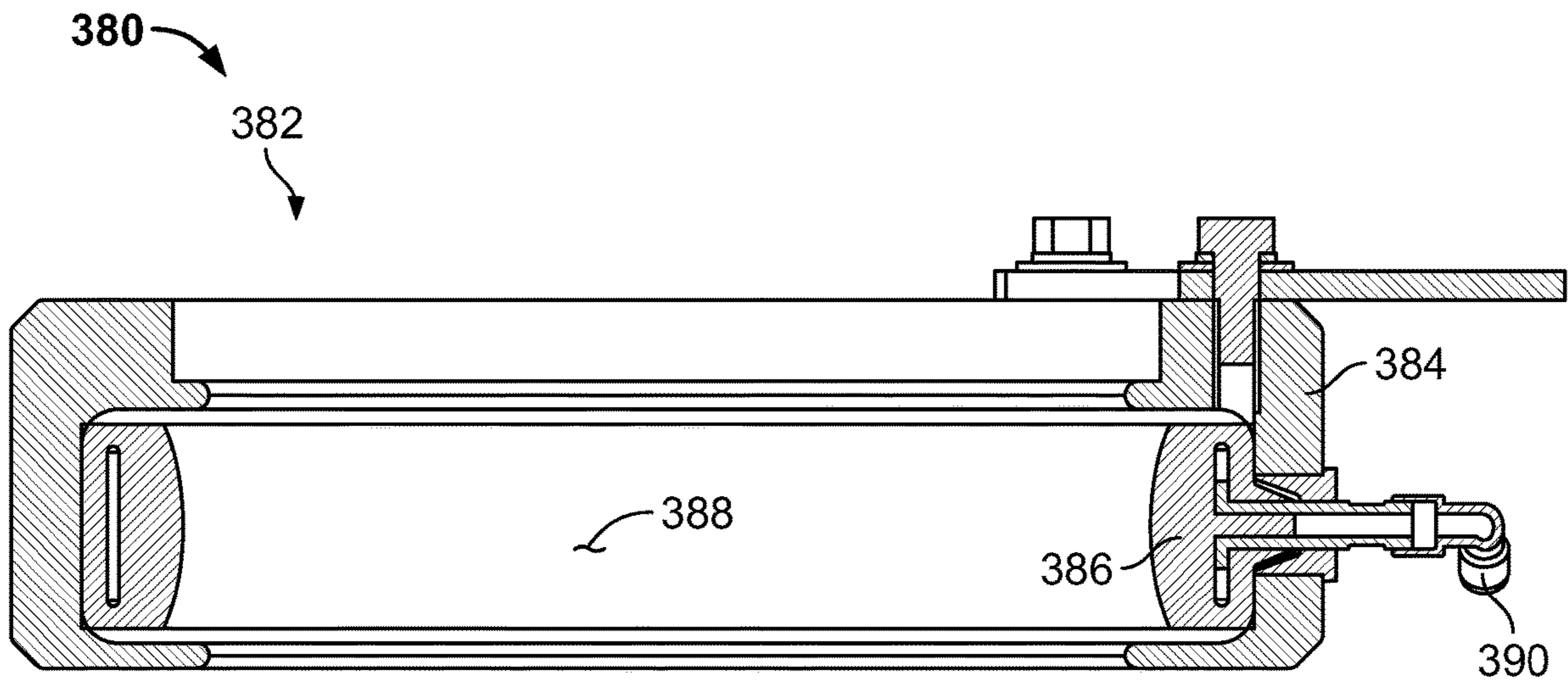


FIG. 15

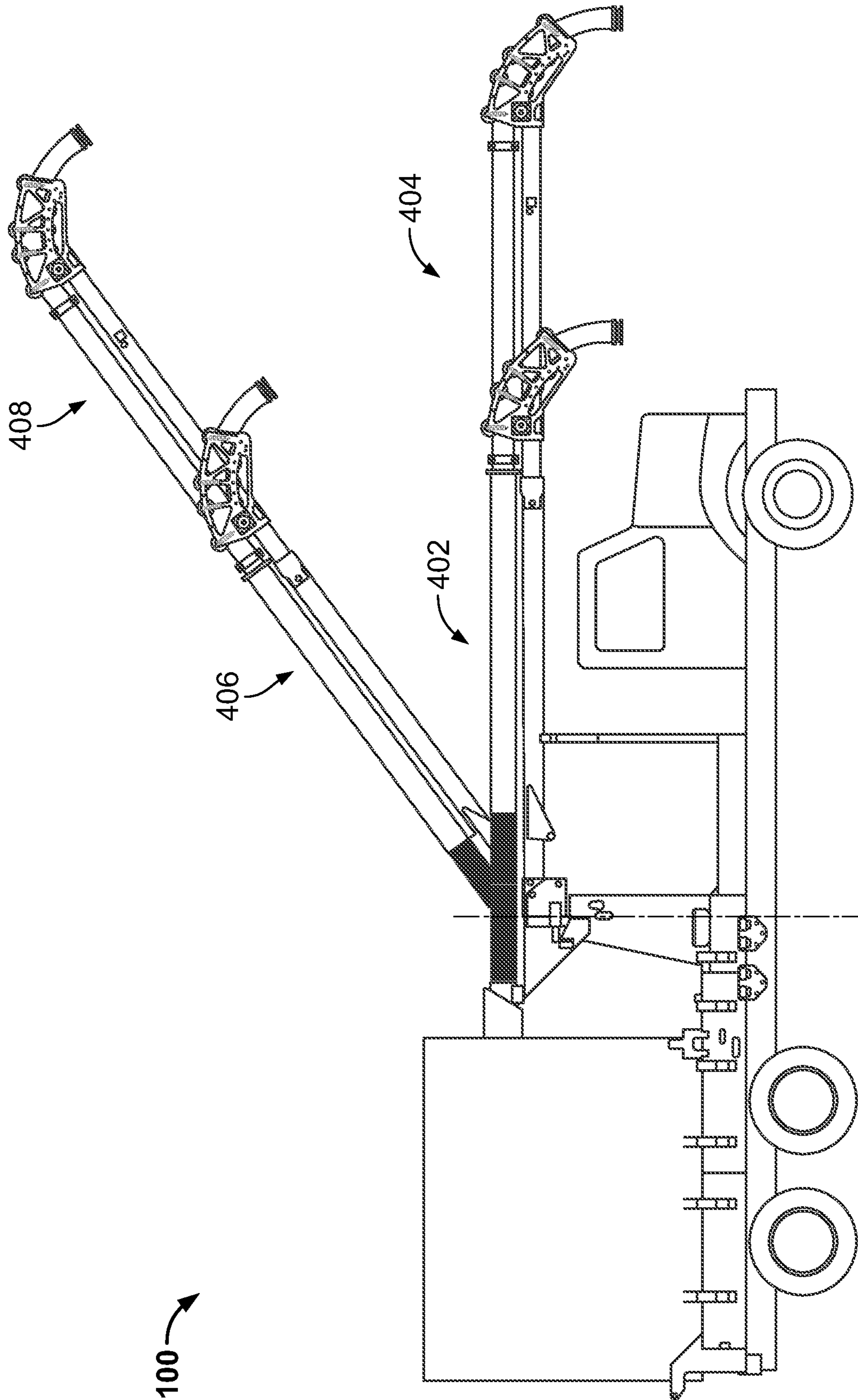


FIG. 16

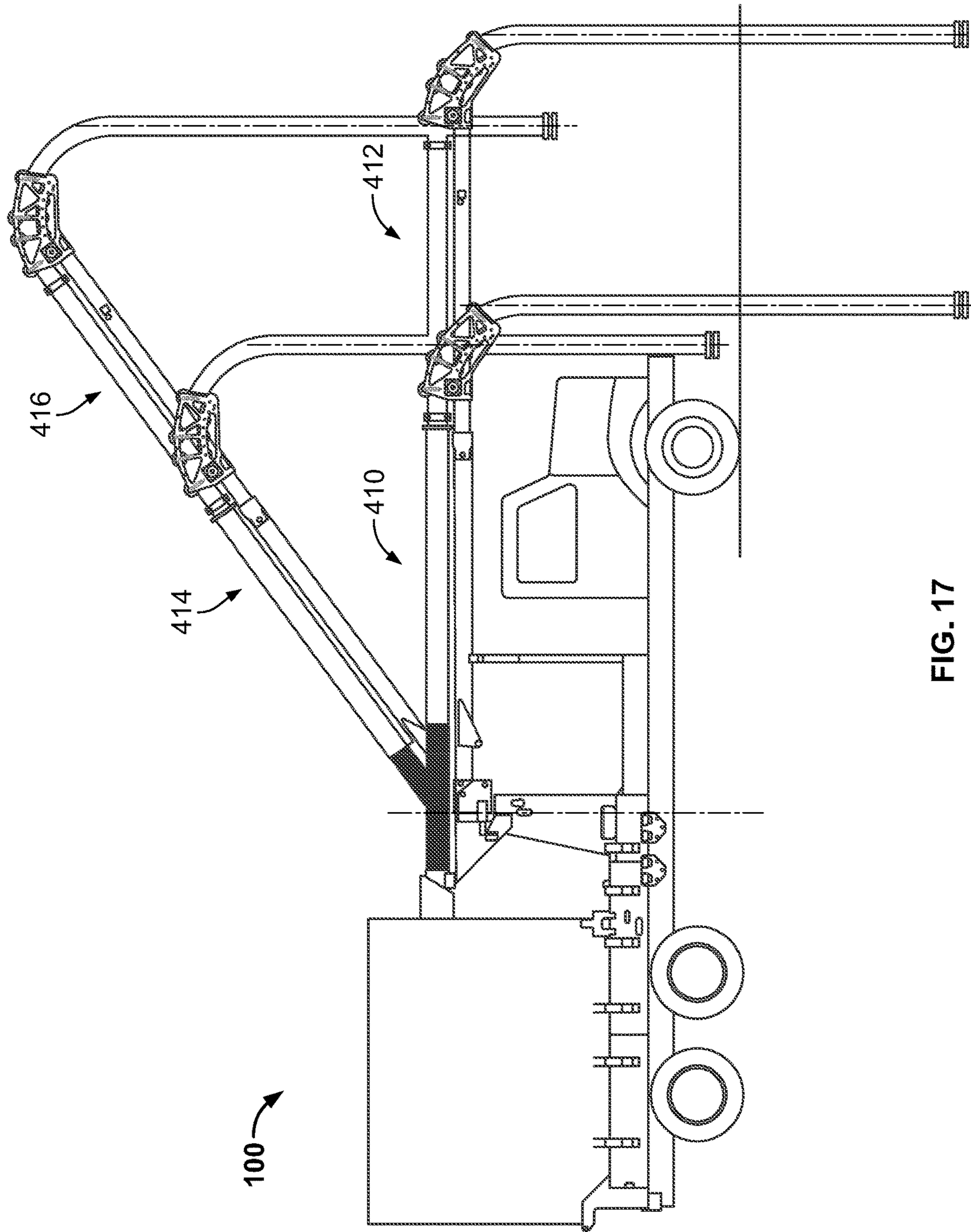


FIG. 17

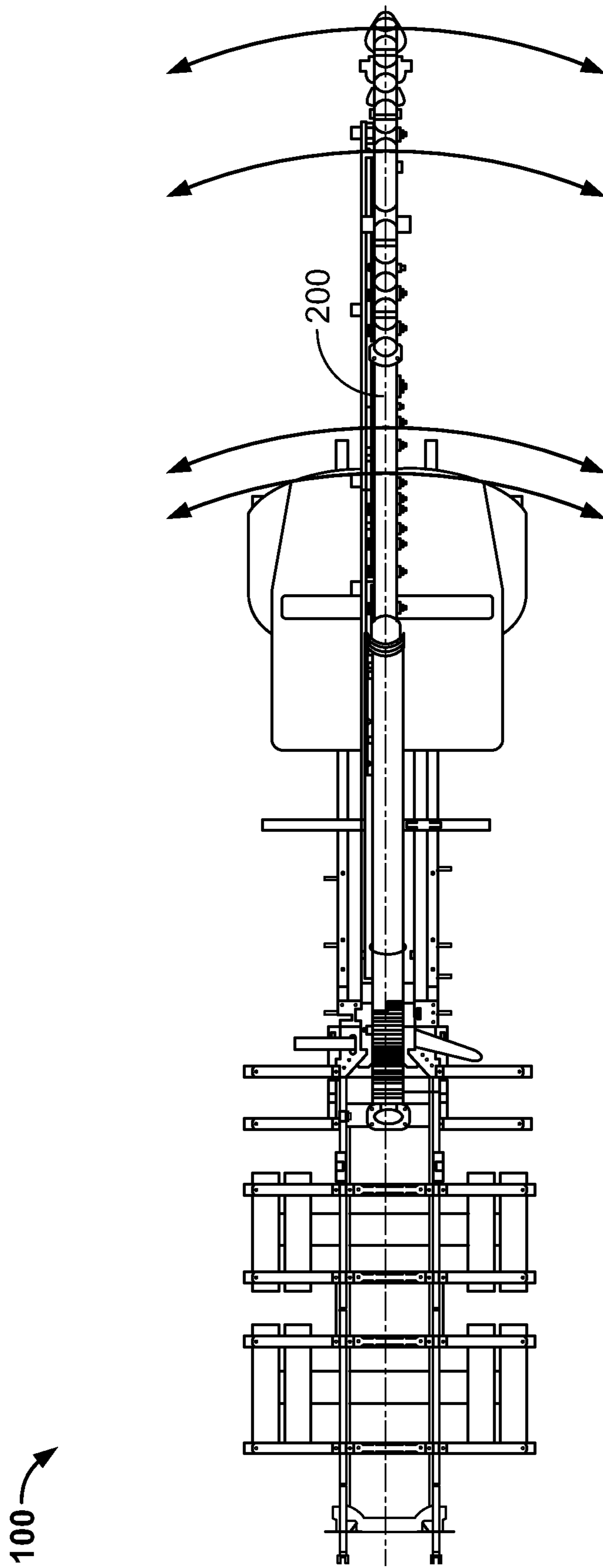


FIG. 18



**1****BOOM HOSE APPARATUS****CROSS REFERENCE TO RELATED APPLICATIONS**

This application is a continuation application of U.S. patent application Ser. No. 15/899,244, filed Feb. 19, 2018, the disclosure of which is incorporated herein by reference in its entirety.

**BACKGROUND**

Tank trucks for collecting and transporting flowable refuse materials, such as storm drain sewage, septic tank sewage, certain chemical waste, leaves and the like, are typically equipped with a collection tank, a vacuum pump, and an at least partially flexible suction hose having one end connected to the tank and an opposite end (i.e., distal end) including a refuse pick-up nozzle. The suction hose may be supported by an adjustable boom on the truck so that at a site of refuse pick-up, the nozzle may be manipulated and positioned relative to the parked truck. For efficient and safe operations, it is desired to provide the ability to adjust the length of the suction hose between the tank of the truck and the pick-up nozzle.

**SUMMARY**

In general terms, the present disclosure is directed to a boom hose apparatus. In one possible configuration and by non-limiting example, the boom hose apparatus is configured for a vehicle and provides features for adjusting the length and position of a flexible hose. Various aspects are described in this disclosure, which include, but are not limited to, the following aspects.

One aspect is a boom hose apparatus for a vehicle. The boom hose apparatus includes a boom assembly and a hose assembly. The boom assembly includes a first boom section and a second boom section telescopically movable relative to the first boom section. The hose assembly is supported on the boom assembly and includes a first conduit, a second conduit, and a flexible hose. The first conduit is mounted to the first boom section and fluidly connected to a collection tank of the vehicle. The second conduit is mounted to the second boom section and telescopically movable relative to the first conduit as the second boom section telescopically moves relative to the first boom section. The flexible hose is received through the second conduit and configured to slidably extend at least partially from the second conduit or retract at least partially into the second conduit.

In certain examples, the boom hose assembly includes a hose drive assembly configured to drive the flexible hose to extend from the second conduit or retract into the second conduit. The hose drive assembly is mounted to the second boom section and movable along with the second boom section as the second boom section telescopically moves relative to the first boom section.

In certain examples, the hose drive assembly includes a housing secured to a front end of the second boom section; a conveyor device arranged in the housing and configured to provide a hose conveyance path along which the flexible hose moves; and a drive motor mounted to the housing and driving the conveyor device. In certain examples, the hose drive assembly further includes one or more idler rollers supported by the housing and arranged opposite to the conveyor device along the hose conveyance path, the idler

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rollers being biased toward the conveyor device to bias the flexible hose against the conveyor device.

In certain examples, the boom hose assembly includes a boom drive assembly configured to drive the second boom section to telescopically move relative to the first boom section.

In certain examples, the boom hose assembly includes a hose end stopper secured to a rearward end of the flexible hose and engageable with a front end of the second conduit to limit movement of the flexible hose relative to the second conduit. In certain examples, the second conduit may have a conduit inner diameter and has a neck portion having a neck inner diameter, the neck inner diameter smaller than the conduit inner diameter. The hose end stopper includes a head portion and a hose fit portion fitted at the rearward end of the flexible hose. The head portion has an external diameter larger than an outer diameter of the flexible hose. The external diameter of the head portion is smaller than the conduit inner diameter of the second conduit and greater than the neck inner diameter of the second conduit.

In certain examples, the boom hose assembly includes a hose clamp device that selectively enables or disable movement of the flexible hose relative to the second conduit. In certain examples, the hose clamp device is arranged at a front end of the second conduit. In certain examples, the hose clamp device includes an inflatable bladder arranged to at least partially surround the flexible hose.

Another aspect is a vehicle including a collection tank, a boom hose assembly, a boom drive assembly, a hose drive assembly, and a boom hose controller. The boom hose apparatus includes a boom assembly and a hose assembly. The boom assembly includes a first boom section and a second boom section telescopically movable relative to the first boom section. The hose assembly is supported on the boom assembly and includes a first conduit, a second conduit, and a flexible hose. The first conduit is mounted to the first boom section and fluidly connected to a collection tank of the vehicle. The second conduit is mounted to the second boom section and telescopically movable relative to the first conduit as the second boom section telescopically moves relative to the first boom section. The flexible hose is received through the second conduit and configured to slidably extend at least partially from the second conduit or retract at least partially into the second conduit. The boom drive assembly is configured to drive the second boom section to telescopically move relative to the first boom section. The hose drive assembly is configured to drive the flexible hose to extend from the second conduit or retract into the second conduit. The boom hose controller is configured to receive a user input for controlling the boom driver and the hose drive assembly.

In certain examples, the hose drive assembly is mounted to the second boom section and movable along with the second boom section as the second boom section telescopically moves relative to the first boom section.

In certain examples, the hose drive assembly includes a housing secured to a front end of the second boom section; a conveyor device arranged in the housing and configured to provide a hose conveyance path along which the flexible hose moves; and a drive motor mounted to the housing and driving the conveyor device. In certain examples, the hose drive assembly further includes one or more idler rollers supported by the housing and arranged opposite to the conveyor device along the hose conveyance path, the idler rollers being biased toward the conveyor device to bias the flexible hose against the conveyor device.

In certain examples, the vehicle includes a hose end stopper secured to a rearward end of the flexible hose and engageable with a front end of the second conduit to limit movement of the flexible hose relative to the second conduit. In certain examples, the second conduit has a conduit inner diameter and has a neck portion having a neck inner diameter, the neck inner diameter smaller than the conduit inner diameter. The hose end stopper includes a head portion and a hose fit portion fitted at the rearward end of the flexible hose. The head portion has an external diameter larger than an outer diameter of the flexible hose. The external diameter of the head portion is smaller than the conduit inner diameter of the second conduit and greater than the neck inner diameter of the second conduit.

In certain examples, the vehicle includes a hose clamp device that selectively enables or disables movement of the flexible hose relative to the second conduit. In certain examples, the hose clamp device is arranged at a front end of the second conduit. In certain examples, the hose clamp device includes an inflatable bladder arranged to at least partially surround the flexible hose.

In certain examples, the boom hose apparatus is connected to a body of the vehicle and pivotable horizontally and vertically relative to the vehicle.

Yet another aspect is a flexible hose for a boom hose apparatus. The boom hose apparatus includes a telescoping boom assembly and a hose assembly supported by the telescoping boom assembly. The hose assembly includes a first conduit and a second conduit telescopically movable relative to the first conduit. The flexible hose is slidably moveable through the second conduit. The flexible housing includes a rearward end, a forward end, and a hose end stopper. The rearward end is in fluid communication with a collection tank. The forward end is opposite to the rearward end and extends out from the second conduit. The hose end stopper is secured to the rearward end and engageable with a front end of the second conduit to limit movement of the flexible hose relative to the second conduit.

In certain examples, the second conduit has a conduit inner diameter and has a neck portion having a neck inner diameter, the neck inner diameter smaller than the conduit inner diameter. The hose end stopper includes a head portion and a hose fit portion fitted at the rearward end of the flexible hose. The head portion has an external diameter larger than an outer diameter of the flexible hose. The external diameter of the head portion is smaller than the conduit inner diameter of the second conduit and greater than the neck inner diameter of the second conduit.

In certain examples, the flexible hose includes a coupling element arranged at the forward end of the flexible hose and configured to attach one or more accessories.

Yet another aspect is a boom hose apparatus for a vehicle. The boom hose apparatus includes a boom assembly and a hose assembly. The boom assembly includes a first boom section and a second boom section telescopically movable relative to the first boom section. The boom assembly is supported on the boom assembly and includes a first conduit and a second conduit. The first conduit is mounted to the first boom section and fluidly connected to a collection tank of the vehicle. The second conduit is mounted to the second boom section and telescopically movable relative to the first conduit as the second boom section telescopically moves relative to the first boom section. The second conduit is configured to slidably receive a flexible hose that is operated

to extend at least partially from the second conduit or retract at least partially into the second conduit.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an example material collection vehicle.

FIG. 2 is a perspective view of an example boom hose apparatus with associated components.

FIG. 3 is another perspective view of the boom hose apparatus of FIG. 2.

FIG. 4 is a perspective view of the boom hose apparatus without the associated components.

FIG. 5 is another perspective view of the boom hose apparatus of FIG. 4.

FIG. 6 is a side view of the boom hose apparatus of FIG. 4 in a first state.

FIG. 7 is a side view of the boom hose apparatus of FIG. 4 in a second state.

FIG. 8 is a side cross sectional view of the boom hose apparatus of FIG. 6.

FIG. 9 is a side cross sectional view of the boom hose apparatus of FIG. 7.

FIG. 10 is a perspective view of an example hose drive assembly.

FIG. 11 is another perspective view of the hose drive assembly of FIG. 10.

FIG. 12 is a side view of an example hose end stopper.

FIG. 13 is a front view of the hose end stopper of FIG. 12.

FIG. 14 is a perspective view of an example hose clamp device.

FIG. 15 is a cross sectional view of the hose clamp device of FIG. 14.

FIG. 16 illustrates various operational states of the boom hose apparatus.

FIG. 17 illustrates other various operational states of the boom hose apparatus.

FIG. 18 illustrates yet other various operational states of the boom hose apparatus.

#### DETAILED DESCRIPTION

Various embodiments will be described in detail with reference to the drawings, wherein like reference numerals represent like parts and assemblies throughout the several views.

In general, a boom hose apparatus is provided for a vehicle with a collection tank. The boom hose assembly includes a telescoping boom assembly and a hose assembly supported by the boom assembly. The boom assembly includes a plurality of telescoping conduits. A flexible hose is received through the telescoping conduits and can slidably extend from, or retract into, the conduits independently from the telescoping of the conduits.

Referring to FIG. 1, a vehicle is described in accordance with an exemplary embodiment of the present disclosure. The vehicle is generally designated by reference number 100 and can also be referred to herein as a material collection vehicle or cleaning vehicle. The vehicle 100 can be of various types. Examples of the vehicle 100 include a dump truck, a vehicle for sewer cleaning or storm drain cleaning, a catch basin cleaning vehicle, a vacuum excavating vehicle, vehicles for leaf collection, litter collection, or hydroexcavation, and any other vehicles having a tank or body for containing a material.

The material collection vehicle 100 includes a cab 102, a vehicle body 104, and a collection tank 106 (also referred to herein as a debris body) mounted to the vehicle body 104.

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The material collection vehicle **100** further includes a boom hose apparatus **200** that is mounted to a boom support structure **108** configured to operatively support the boom hose apparatus **200**.

The collection tank **106** is used to collect a material, such as debris, sludge, solids, liquids, slurries, and other materials removed from an area being cleaned. In some examples, the collection tank **106** is pivotally mounted to the body **104** adjacent the rear of the body **104** and the front of the collection tank **106** lifts off the body **104** and is tilted for dumping the material collected in the collection tank **106**. The rear end of the collection tank **106** includes a pivotally mounted door coupled to the remainder of the collection tank **106**.

The boom hose apparatus **200** includes a hose (including a flexible hose **234** as described herein) (also referred to herein as a suction hose or a vacuum hose) that is fluidly connected to the collection tank **106** at one end and is configured to extend down to an area being cleaned. A vacuum pump **110** is provided at the vehicle **100** and configured to create a negative pressure inside of the collection tank **106**. The area being cleaned is sucked up with materials, such as debris, through the flexible hose and deposited into the collection tank **106**. An example of the boom hose apparatus **200** is further described and illustrated herein.

The boom hose apparatus **200** can be operated by a user via a control panel **112**. The control panel **112** provides a boom hose controller **113** configured to receive a user input for operating and controlling the boom hose apparatus **200** (e.g., a boom drive assembly **206** and a hose drive assembly **208** as described herein). The boom hose controller **113** can include one or more physical control elements, such as buttons, switches, levers, selectors, and joysticks. In other examples, the boom hose controller **113** includes electronic control elements. The control panel **112** also provide control elements for operating and controlling other parts, components, and devices of the vehicle **100**. Similar to the boom hose controller **113**, such other control elements of the control panel **112** can include physical control elements, such as buttons, switches, levers, selectors, and joysticks. In other examples, the control panel **112** includes electronic control elements. For example, the control panel **112** can be integrated with a display device, such as a touch sensitive display screen, and include graphical user interface control elements or widgets.

As described herein, the boom hose apparatus **200** is operated to various positions. The boom hose apparatus **200** may be pivotally connected to the vehicle body **104**. For example, The boom hose apparatus **200** is coupled to the boom support structure **108** and pivoted to swing horizontally (side-to-side) and vertically (up and down) over the cab **102** relative to the ground. Example operations of the boom hose apparatus **200** are further described and illustrated with reference to FIGS. **16-18**.

Referring to FIGS. **2-9**, the boom hose apparatus **200** is illustrated and described in accordance with an exemplary embodiment of the present disclosure. The boom hose apparatus **200** includes a boom assembly **202**, a hose assembly **204**, a boom drive assembly **206**, and a hose drive assembly **208**.

The boom assembly **202** includes a plurality of boom sections that are telescopically movable relative to one another. In this example, the boom assembly **202** includes a first boom section **210** and a second boom section **212** that is telescopically movable relative to the first boom section **210**. In some examples, the first boom section **210** is

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configured as a hollow tube so that the second boom section **212** is movably received in the first boom section **210**. As illustrated in FIGS. **6** and **7**, in some examples, the second boom section **212** is configured to have a smaller cross sectional profile than the first boom section **210** so as to be received in the first boom section **210**. The second boom section **212** is movably engaged with the first boom section **210** and can be retracted and extended relative to the first boom section **210** along a longitudinal direction **D1**. For example, in FIGS. **6** and **8**, the boom assembly **202** is in a collapsed state where the second boom section **212** is retracted into the first boom section **210**. In FIGS. **7** and **9**, the boom assembly **202** is in an extended state (also referred to herein as a telescoped state) where the second boom section **212** is extended out, or telescoped, from the first boom section **210** along the longitudinal direction **D1**.

The first boom section **210** extends between a rear end **214** (also referred to herein as a proximal end) and a front end **216** (also referred to herein as a distal end), and the rear end **214** of the first boom section **210** can be pivotally coupled to the vehicle body **104** (such as to the boom support structure **108**) for horizontal and/or vertical swinging movement over the vehicle cab **102**. The front end **216** of the first boom section **210** is open so that the second boom section **212** is movably received in the first boom section **210** therethrough.

As illustrated in FIGS. **8** and **9**, the second boom section **212** extends between a rear end **218** (also referred to herein as a proximal end) and a front end **220** (also referred to herein as a distal end). The second boom section **212** is received in the first boom section **210** such that the rear end **218** is received within the first boom section **210** and the front end **220** extends out from the front end **216** of the first boom section **210**. As described herein, the front end **220** of the second boom section **212** is configured to mount the hose drive assembly **208**.

The telescoping movement of the boom assembly **202** is operated by the boom drive assembly **206**. As illustrated in FIGS. **8** and **9**, the boom drive assembly **206** can be disposed within the boom assembly **202**. The boom drive assembly **206** can operate to drive the second boom section **212** to telescopically move relative to the first boom section **210**. In some examples, as illustrated in FIG. **9**, the boom drive assembly **206** is engaged with the boom assembly **202** and controlled by a boom drive circuit **203**. The boom drive circuit **203** operates to receive a signal representative of a user input from the control panel **112**, and control the boom drive assembly **206** based on signal. The boom drive assembly **206** can be of various configurations, such as a retractable shaft assembly that can be hydraulically operated.

In some examples, a conduit **207** can be provided to route hoses and/or cables to the hose drive assembly **208**. The conduit **207** can be disposed adjacent the boom assembly **202** and extend at least partially along the length of the boom assembly **202**. The conduit **207** can be configured to extend and retract with the boom assembly **202**.

The hose assembly **204** is supported by the boom assembly **202**. The hose assembly **204** includes a first conduit **230** (also referred to herein as a first tube), a second conduit **232** (also referred to herein as a second tube), and a flexible hose **234**.

The first conduit **230** is mounted to the first boom section **210**. The first conduit **230** is configured as an open-ended hollow conduit or tube to movably receive the second conduit **232** therein. The first conduit **230** may be made of inflexible material, such as metal or plastic. The first conduit **230** may be secured to the first boom section **210** using one

or more brackets, such as a first bracket **240** and a second bracket **242**. In this example, the first bracket **240** is provided at a rear end **244** of the first conduit **230**, and the second bracket **242** is provided adjacent a front end **246** of the first conduit **230**. In some examples, the first bracket **240** fixedly mounts the rear end **244** of the first conduit **230** to the first boom section **210**, and the second bracket **242** is configured to be spring loaded to flexibly support the first conduit **230** against the first boom section **210**.

The first conduit **230** can be fluidly connected to the collection tank **106** of the vehicle **100** at the rear end **244**. In the illustrated example, a bellows tube **250** is used to fluidly connect the rear end **244** of the first conduit **230** to the collection tank **106**. In other examples, other element can be used to fluidly couple the first conduit **230** to the collection tank **106**. In yet other examples, the first conduit **230** is directly connected to the collection tank **106**.

The second conduit **232** is mounted to the second boom section **212** and telescopically movable relative to the first conduit **230** when the second boom section **212** telescopically moves relative to the first boom section **210**. In this example, the second conduit **232** is slidably received into the first conduit **230** and can be retracted and extended relative to the first conduit **230** along the longitudinal direction **D1**. The second conduit **232** is configured as an open-ended hollow conduit or tube so that the flexible hose **234** can pass through the second conduit **232**. The second conduit **232** may be made of inflexible material, such as metal or plastic. The second conduit **232** can be secured to the second boom section **212** using one or more brackets. In this example, a third bracket **260** is provided at a front end **264** of the second conduit **232** so that the front end **264** of the third bracket **260** is fixed to the second boom section **212** adjacent the front end **220** of the second boom section **212**. Regardless of a position of the second conduit **232** relative to the first conduit **230**, a portion of the second conduit **232** adjacent a rear end **262** thereof can be received within the first conduit **230** so that the second conduit **232** is supported at the rear end **262** while the front end **264** of the second conduit **232** is supported by the second boom section **212**.

Because the first conduit **230** is secured to the first boom section **210** and the second conduit **232** is secured to the second boom section **212**, the telescoping operation of the boom assembly **202** causes a corresponding telescoping movement of the second conduit **232** relative to the first conduit **230**. For example, when the boom assembly **202** is in the collapsed state (FIGS. **6** and **8**), the second conduit **232** is retracted into the first conduit **230**. When the boom assembly **202** is in the extended state (FIGS. **7** and **9**), the second conduit **232** is extended from the first conduit **230**.

The flexible hose **234** extends between a rearward end **270** and a forward end **272**. The rearward end **270** of the flexible hose **234** remains in fluid communication with the collection tank **106**, and the forward end **272** of the flexible hose **234** is configured extend down to a service area, such as on the ground or a sewer.

The flexible hose **234** can be received through the second conduit **232** and configured to extend slidably through the second conduit **232**. The flexible hose **234** can be slidably extend at least partially from the front end **264** of the second conduit **232** and retract at least partially into the second conduit **232** through the front end **264** thereof. In some examples, the flexible hose **234** can extend through a front end (e.g., an inlet) of the collection tank **106** so that a portion of the hose **234** can be stored in the collection tank **106**.

The flexible hose **234** can be independently operated to extend from, and retract into, the second conduit **232**.

Regardless of the position of the boom assembly **202** (e.g., either in the collapsed state or the extended state, the flexible hose **234** can be operated to move through the second conduit **232**, such as between a retracted position (as illustrated in FIG. **16**) or an extended position (as illustrated in FIG. **17**).

The flexible hose **234** can be made in various lengths. In some examples, the flexible hose **234** is configured to have a length between the rearward end **270** and the forward end **272** that does not require one or more additional extension hoses to be coupled to the forward end **272** of the flexible hose **234** in most situations. In other examples, the flexible hose **234** is configured to have a length such that the rearward end **270** extends out from the rear end **244** of the first conduit **230** when the flexible hose **234** is in the retracted position.

The hose drive assembly **208** is configured to drive the hose **234** to slide forward or backward through the second conduit **232**, thereby adjusting the length of the hose **234** available to accommodate varying distances between the vehicle **100** (e.g., a distal end of the apparatus **200**) and the a point of refuse pickup. In some examples, the hose drive assembly **208** is mounted to the second boom section **212** and thus movable together with the second boom section **212** as the second boom section **212** telescopically moves relative to the first boom section **210**. In the illustrated example, the hose drive assembly **208** is secured to the front end **220** of the second boom section **212**.

In some examples, the flexible hose **234** has a coupling element **252**, such as a clamping device, arranged at the forward end **272**, which is configured to attach various accessories, such as a metal extension tube or conduit **254**.

Referring to FIGS. **10** and **11**, an example of the hose drive assembly **208** is further illustrated and described. The hose drive assembly **208** includes a housing **302** secured to the front end **220** of the second boom section **212**. In some examples, the housing **302** includes a pair of side members **306** that are spaced apart to define a hose conveyance path **304** therebetween. The flexible hose **234** travels along the hose conveyance path **304**.

The hose drive assembly **208** includes a conveyor device **308** arranged in the housing **302** and configured to provide the hose conveyance path **304** thereon. In some examples, the conveyor device **308** is disposed between the pair of side members **306** at a lower side **310** of the housing **302**.

The conveyor device **308** may include one or more rollers **312** and a conveyor belt **314**. In some examples, the rollers **312** are arranged at the lower side **310** of the housing **302** between the pair of side members **306**, and the conveyor belt **314** is trained around the rollers **312** and arranged to travel along the hose conveyance path **304**. The conveyor belt **314** is configured to be in frictional engagement with the flexible hose **234** for drawing the hose **234** out or into the second conduit **232** to vary the length of the hose **234** outside the second conduit **232**.

In some examples, at least one of the rollers **312** is configured as a drive roller **315** and driven by a drive motor **320**. The drive motor **320** can drive the drive roller **315** in reverse directions, so that the conveyor belt **314** travels forwards or backwards along the hose conveyance path **304**. The drive motor **320** can be of various types, such as a hydraulic motor, a pneumatic motor, or an electric motor. The drive motor **320** can be connected directly to the drive roller **315**, or connected to the drive roller **315** via a transmission device. In other examples, a plurality of motors can be used to drive at least one of the rollers **312**.

As described herein, the drive motor **320** is controlled by a hose control circuit **209**. The hose control circuit **209** is configured to receive a signal representative of a user input from the control panel **112**, and control the drive motor **320** based on the signal.

Although it is described in this example that the boom drive circuit **203** and the hose control circuit **209** are separate, it is understood that the boom drive circuit **203** and the hose control circuit **209** is integrated to a single circuit.

The hose drive assembly **208** can further include one or more idler rollers **316** supported by the housing **302**. In some examples, the idler rollers **316** are disposed at an upper side **318** of the housing **302** between the side members **306** and arranged opposite to the conveyor device **308** along the hose conveyance path **304**. The hose conveyance path **304** is defined between the conveyor device **308** and the idler rollers **316**.

In some examples, the idler rollers **316** are arranged to be biased toward the conveyor device **308** and press the flexible hose **234** against the conveyor device **308**. The pressure generated by the idler rollers **316** against the conveyor device **308** increases a friction between the flexible hose **234** and the conveyor belt **314** of the conveyor device **308**, thereby improving the travel of the hose **234** along the hose conveyance path **304**. The idler rollers **316** can be configured as axially concave rollers to accommodate the round shape of the flexible hose **234**. In some examples, one or more spring devices **322** are provided to bias the idler rollers **316** toward the conveyor device **308**.

As illustrated, the hose drive assembly **208** is configured to provide an arcuate hose conveyance path **304** such that the flexible hose **234** is naturally flexed by gravity as the hose **234** extends from, or retracts into, the second conduit **232**.

Although it is primarily described herein that the conveyor device **308** is arranged at the lower side **310** of the housing **302** and the idler rollers **316** are arranged at the upper side **318** of the housing **302**, it is understood that the conveyor device **308** and the idler rollers **316** are arranged in different configurations, such as where the conveyor device **308** is arranged at the upper side **318** of the housing **302** and the idler rollers **316** are arranged at the lower side **310** of the housing **302**.

In some examples, a hose end stopper **350** is secured to the rearward end **270** of the flexible hose **234**, as illustrated in FIGS. **8** and **9**. The hose end stopper **350** is configured to limit movement of the flexible hose **234** relative to the second conduit **232**. For example, the hose end stopper **350** is configured to engage with the rear end **262** of the second conduit **232** when the rearward end **270** of the flexible hose **234** reaches the rear end **262** of the second conduit **232**. In other examples, the hose end stopper **350** is configured to engage with the front end **264** of the second conduit **232** when the rearward end **270** of the flexible hose **234** reaches the front end **264** of the second conduit **232**. Other locations of the second conduit **232** can be configured to engage with the hose end stopper **350** to prevent a forward movement of the flexible hose **234**.

Referring to FIGS. **12** and **13**, an example of the hose end stopper **350** is illustrated and described. The hose end stopper **350** includes a head portion **352** and a hose fit portion **354** extending from the head portion **352**. The hose fit portion **354** is configured to fit to the rearward end **270** of the flexible hose **234** so that the head portion **352** seats on the rearward end **270** of the flexible hose **234**. The head portion **352** has an external diameter  $D_H$  larger than an outer diameter  $D_O$  (FIG. **8**) of the flexible hose **234** and smaller than an inner diameter  $D_I$  of the second conduit **232**.

In some examples, the second conduit **232** includes a neck portion **360** having a neck inner diameter  $D_N$  smaller than the inner diameter  $D_I$  of the second conduit **232**. The neck inner diameter  $D_N$  (FIG. **8**) can be smaller than the external diameter  $D_H$  of the head portion **352** of the hose end stopper **350**, so that the flexible hose **234** stops traveling when the head portion **352** of hose end stopper **350** engages with the neck portion **360** of the second conduit **232**.

The neck portion **360** can be arranged in various locations along the length of the second conduit **232**. In the illustrated example, the neck portion **360** is provided at the rear end **262** of the second conduit **232**. In this configuration, the flexible hose **234** can be substantially entirely drawn out from the second conduit **232** until the rearward end **270** of the hose **234** engages with the rear end **262** of the second conduit **232**. In other examples, the neck portion **360** can be arranged at different locations of the second conduit **232**.

The hose end stopper **350** can be secured to the rearward end **270** of the flexible hose **234** in various methods. In some examples, the hose end stopper **350** is molded into the hose **234**. In other examples, the hose end stopper **350** is glued to the hose **234**. In yet other examples, the hose end stopper **350** is bolted to the hose **234**. In yet other examples, the hose end stopper **350** is clamped to the hose **234**. In yet other examples, the hose end stopper **350** is injection molded to the hose **234**. In yet other examples, the hose end stopper **350** is riveted to the hose **234**. In yet other examples, the hose end stopper **350** is screwed to the hose **234**. In yet other examples, the hose end stopper **350** is threaded to the hose **234**. In yet other examples, the hose end stopper **350** is fastened to the hose **234**. In yet other examples, the hose end stopper **350** is threaded and fastened to the hose **234**. In yet other examples, the hose end stopper **350** is swaged to the hose **234**. In yet other examples, the hose end stopper **350** is interference fitted (e.g., press fitted) to the hose **234**. In yet other examples, the hose end stopper **350** is welded to the hose **234**. In yet other examples, the hose end stopper **350** is secured to the hose **234** using adhesive.

The hose end stopper **350** allows a simple mechanical stop for movement of the flexible hose **234** in the boom assembly **202** and eliminates the user's concern about an exact point where the operation of the flexible hose **234** should be manually stopped before the flexible hose **234** is accidentally removed from the boom assembly **202**. Further, the hose end stopper **350** reduces the effect of erosion during operation as the hose end stopper **350** is flush with the inside the hose. Moreover, there is no fastener or other element in the air stream to be worn off.

Referring again to FIGS. **2-9**, the boom hose apparatus **200** can include a hose clamp device **380** configured to selectively enable or disable movement of the flexible hose **234** relative to the second conduit **232**. In some examples, the hose clamp device **380** is arranged between the front end **264** of the second conduit **232** and the hose drive assembly **208**. For example, the hose clamp device **380** is disposed at the front end **264** of the second conduit **232**. The hose clamp device **380** can be secured to the second conduit **232** and/or to the second boom section **212** so that the hose clamp device **380** moves together with the second conduit **232** and the second boom section **212**.

Referring to FIGS. **14** and **15**, an example of the hose clamp device **380** is illustrated and described. The hose clamp device **380** includes an inflatable bladder **382** configured and arranged to at least partially surround the flexible hose **234**. The inflatable bladder **382** can include a ring-shaped housing **384** and an inflatable tube **386** mounted to an inner diameter of the housing **384**. The inflatable tube

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386 is configured to a circular tube defining a bore 388 through which the flexible hose 234 passes. The inflatable tube 386 inflates and clamps the flexible hose 234 as air is supplied via an inlet 390. As air is drawn via the inlet 390, the inflatable tube 386 deflates and releases the flexible hose 234 so that the flexible hose 234 freely moves through the bore 388.

Referring to FIGS. 16-18, example operational states and positions of the boom hose apparatus 200 are illustrated and described. As illustrated in FIG. 16, the boom hose apparatus 200 can be operated to a first operational state 402, a second operational state 404, a third operational state 406, and a fourth operational state 408. In the first operational state 402, the boom hose apparatus 200 is lowered horizontally, the boom assembly 202 is in the collapsed state, and the flexible hose 234 is in the retracted position. In the second operational state 404, the boom hose apparatus 200 is lowered horizontally, the boom assembly 202 is in the extended state, and the flexible hose 234 is in the retracted position. In the third operational state 406, the boom hose apparatus 200 is pivoted up, the boom assembly 202 is in the collapsed state, and the flexible hose 234 is in the retracted position. In the fourth operational state 408, the boom hose apparatus 200 is pivoted up, the boom assembly 202 is in the extended state, and the flexible hose 234 is in the retracted position.

As illustrated in FIG. 17, the boom hose apparatus 200 can be operated to a fifth operational state 410, a sixth operational state 412, a seventh operational state 414, and an eighth operational state 416. In the fifth operational state 410, the boom hose apparatus 200 is lowered horizontally, the boom assembly 202 is in the collapsed state, and the flexible hose 234 is in the extended position. In the sixth operational state 412, the boom hose apparatus 200 is lowered horizontally, the boom assembly 202 is in the extended state, and the flexible hose 234 is in the extended position. In the seventh operational state 414, the boom hose apparatus 200 is pivoted up, the boom assembly 202 is in the collapsed state, and the flexible hose 234 is in the extended position. In the eighth operational state 416, the boom hose apparatus 200 is pivoted up, the boom assembly 202 is in the extended state, and the flexible hose 234 is in the extended position.

As such, the flexible hose 234 can be operated independently from the states of the boom assembly 202. Regardless of the length of the second conduit 232 telescoped out from the first conduit 230, the same amount of the flexible hose 234 remains available to be driven out from the second conduit 232. As such, according to the boom hose apparatus 200 of the present disclosure, the amount of the flexible hose 234 does not decrease as the boom assembly 202 is telescoped out, and thus the operator can take full advantage of both the telescoping of the boom assembly and the extension of the flexible hose length.

As illustrated in FIG. 18, the boom hose apparatus 200 can also be operated to pivot to swing horizontally (side-to-side) over the cab 102 relative to the ground. The boom hose apparatus 200 can be operated to any of the first, second,

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third, fourth, fifth, sixth, seventh, and eighth operational states 402, 404, 406, 408, 410, 412, 414, and 416.

The various examples and teachings described above are provided by way of illustration only and should not be construed to limit the scope of the present disclosure. Those skilled in the art will readily recognize various modifications and changes that may be made without following the examples and applications illustrated and described herein, and without departing from the true spirit and scope of the present disclosure.

What is claimed is:

1. A flexible hose for a boom hose apparatus, the boom hose apparatus including a telescoping boom assembly and a hose assembly supported by the telescoping boom assembly, the hose assembly including a first conduit and a second conduit telescopically movable relative to the first conduit, the flexible hose slidably moveable through the second conduit; the flexible hose comprising:

a rearward end being in fluid communication with a collection tank;

a forward end opposite to the rearward end and extending out from the second conduit; and

a hose end stopper secured to the rearward end and engageable with a front end of the second conduit to limit movement of the flexible hose relative to the second conduit.

2. The flexible hose of claim 1, further comprising:

a coupling element arranged at the forward end of the flexible hose and configured to attach one or more accessories.

3. A flexible hose for a boom hose apparatus, the boom hose apparatus including a telescoping boom assembly and a hose assembly supported by the telescoping boom assembly, the hose assembly including a first conduit and a second conduit telescopically movable relative to the first conduit, the flexible hose slidably moveable through the second conduit; the flexible hose comprising:

a rearward end being in fluid communication with a collection tank;

a forward end opposite to the rearward end and extending out from the second conduit;

a hose end stopper secured to the rearward end and engageable with a front end of the second conduit to limit movement of the flexible hose relative to the second conduit;

the second conduit having a conduit inner diameter and a neck portion having a neck inner diameter, the neck inner diameter being smaller than the conduit inner diameter,

the hose end stopper including a head portion and a hose fit portion fitted at the rearward end of the flexible hose; and

the head portion having an external diameter larger than an outer diameter of the flexible hose, the external diameter of the head portion being smaller than the conduit inner diameter of the second conduit and greater than the neck inner diameter of the second conduit.

\* \* \* \* \*